

# Outdoor Point-to-Point Deployment

Version 1.0

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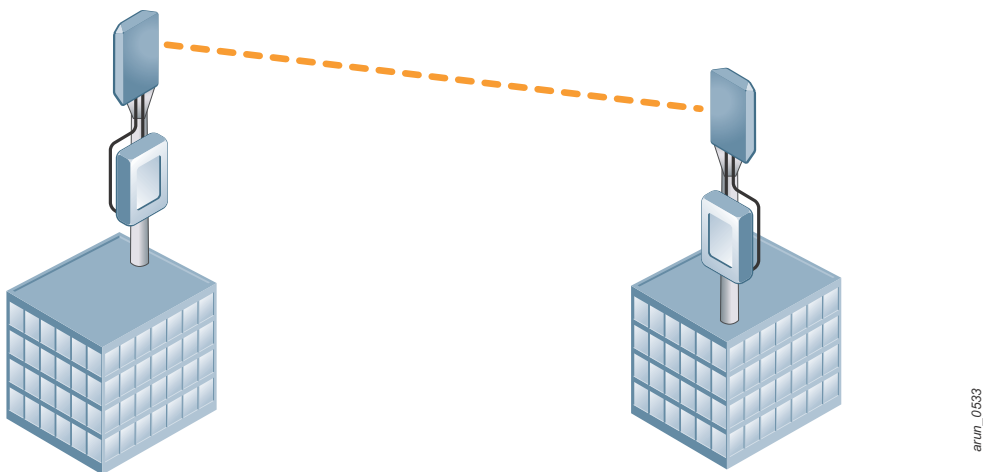
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# Chapter 1: Introduction

This guide provides information to help you successfully deploy an outdoor point-to-point mesh link and help you make the right hardware choices based on project requirements. This guide provides an overview of some of the challenges in deploying an outdoor point-to-point deployment. This guide also provides a step-by-step configuration procedure to set up ArubaOS and MeshOS access points (APs). This guide assumes you have basic understanding of Aruba products and radio frequency (RF) design principles.

These topics are covered in detail:

- requirements for successful outdoor deployments
- case study of a point-to-point deployment
- selecting the right APs and antennas
- installing point-to-point mesh links
- setup, configuration, and validation of an MSR 2000
- setup, configuration, and validation of an AP-175



**Figure 1**     *Point-to-point deployment*

Table 1 lists the current software versions for this guide.

**Table 1**     **Aruba Software Versions**

Product	Version
ArubaOS™ (mobility controllers)	6.1
ArubaOS (mobility access switch)	7.0
Aruba Instant™	1.1
MeshOS	4.2
AirWave	7.3
AmigopodOS	3.3

## Reference Material

- This guide assumes a working knowledge of Aruba products. This guide is based on the network detailed in the *Aruba Campus Wireless Networks VRD* and the *Base Designs Lab Setup for Validated Reference Design*. These guides are available at <http://www.arubanetworks.com/vrd>.
- The complete suite of Aruba technical documentation is available for download from the Aruba support site. These documents present complete, detailed feature and functionality explanations outside the scope of the VRD series. The Aruba support site is located at: <https://support.arubanetworks.com/>. This site requires a user login and is for current Aruba customers with support contracts.
- This guide references these product guides, which are available on the Aruba support site:
  - software user guide for ArubaOS 6.1
  - hardware installation guides for the Aruba MSR2000 and AP-175 APs
  - software user guide for MeshOS 4.2

## Chapter 2: Point-to-Point Networks

Deploying a point-to-point mesh network is the quickest and the most cost-effective method of transferring data between two points in an outdoor campus network. In a mesh, the total cost of ownership per gigabit is much lower than other commonly used WAN networks such as fiber or DSL.

802.11n is the new wireless standard that is capable of speeds up to 450 Mb/s per radio. Over the past decade, the demand has exploded for low-cost, high-capacity outdoor networks that are quick and easy to deploy. With mainstream adoption of the 802.11n standard, outdoor Wi-Fi based mesh networks have redefined the dollar per gigabit ratio and have now become a leading contender in the low-cost, high-capacity network segment.

The Aruba AirMesh MSR4000 802.11n mesh products are capable of achieving a combined total data rate of up to 1.2 Gb/s per AP for a fraction of the cost of other mainstream wireless technologies, such as 3G or 4G cellular data networks. These factors have contributed to the wider acceptance of Wi-Fi-based, outdoor mesh networks:

- huge increase in capacity
- free-spectrum availability
- increased reliability with the adoption of MIMO, which is a critical component of 802.11n standard

In an outdoor deployment, the type of external antenna used with these APs is equally important as choosing the right outdoor APs. The wide range of Aruba outdoor products takes full advantage of the new MIMO functionalities by utilizing specially designed cross-polarized MIMO antennas with all new 802.11n APs. This guide provides all the information to help you successfully deploy a point-to-point mesh link.

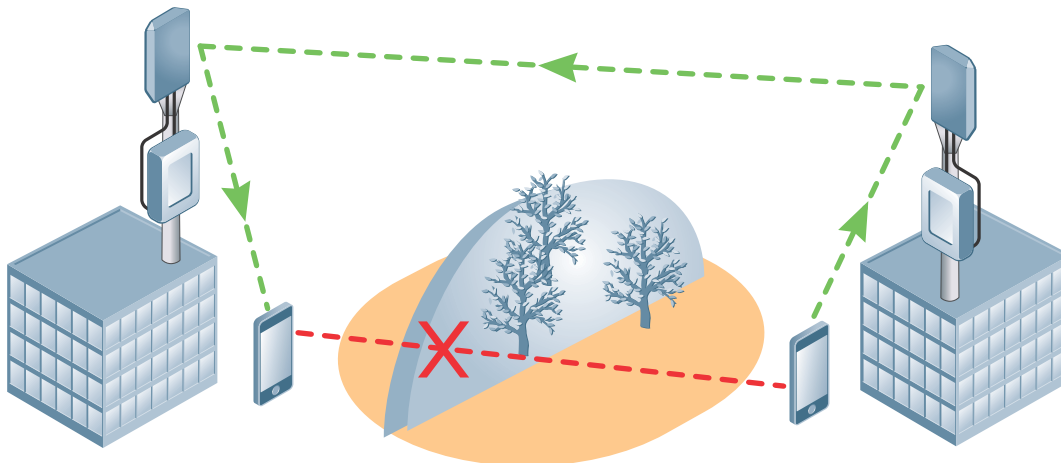


## Chapter 3: Requirements for Successful Deployments

To deploy a network successfully, you first must understand the various components involved. Before you begin the deployment, you must consider not only the required hardware products, but also the line of sight (LoS), site acquisition, and people and resources. These factors influence the type of outdoor hardware to be used, the mounting location for each AP, and total cost of the project.

### Line of Sight

RF LoS between two mesh APs is required for successful deployment of a point-to-point mesh network. RF LoS is not the same as being able to see from one AP to another, known as visual LoS. With deployments greater than a few kilometers, it is typical that the installer will not be able to see the far AP at either end of the network. However the two APs might still have good RF LoS because RF LoS is not constrained by the same limitation as the visual LoS. One of the biggest factors that influences RF LoS is Fresnel zone clearance between the two AP points. For complete information about Fresnel zone clearance and calculations, see the Installation chapter.



**Figure 2** RF LoS vs. Visual LoS

## Site Acquisition

Outdoor mesh networks typically span multiple kilometers. Unlike indoor wireless networks, the necessary equipment is not mounted in a single building within a campus. APs and antennas are usually placed on multiple buildings to cover the entire area. Sometimes the optimum locations chosen for mounting APs and antennas are not within one of the buildings owned by the organization that is deploying the mesh network. In these situations, project managers must negotiate space and lease agreements to mount APs and antennas on rooftops or light poles often owned by a different entity. It is critical that the chosen mounting locations be as close to optimum as possible for the placement of APs and antennas. To provide you with high-level understanding of deploying a simple point-to-point mesh network, [Table 2](#) lists the essentials items that are required at each site to successfully bring up a single mesh node.

**Table 2 Site Acquisition Requirements**

Required Items	Comments
Power (AC/ DC/ Power over Ethernet)	A reliable power source is required next to the AP mounting location to power the APs.
Ethernet or fiber network (backhaul)	Ethernet or fiber network backhaul is required at certain location (depending on network design) to backhaul wireless mesh traffic to the data center.
Lease agreements and legal approvals	Lease agreement should be in place to mount the APs and antennas at the defined location.

### Power

Each location must have a power supply for the APs. Always make sure that the electricity required for powering the AP and any accessories such as cameras or data storage equipment is accounted for in the lease agreement. Deploying power to a site can be an expensive undertaking, but you can optimize the expense. Something as simple as using the right power source (AC, PoE+, or DC) can amount to additional savings in the deployment phase.

**Table 3 AP Power Options**

Outdoor AP	Available Power Options
AP-175	AC / DC / PoE+
MSR-2000	AC / DC / PoE+
MSR-4000	AC / PoE+



Choosing the right power input depends on the AP type that is to be mounted and its corresponding power source. Factors such as existing wiring and network infrastructure also must be considered. Refer to the data sheet for the specific Aruba AP model for different power requirements.

## Power over Ethernet Plus (PoE+)

All Aruba outdoor AP models except MSR 4000 are equipped with a standard-based PoE+ input port that can be used to power the APs. For ease of deployment, APs that require network backhaul should be powered with PoE+ where possible. An Ethernet cable already is being provisioned to the AP for network backhaul, so it saves time and money to use the same wiring to power the APs. PoE+ requires that only one conduit is constructed and PoE may be deployed by a structured cabling resource. Standalone mesh APs can be powered with an external PoE+ injector that converts AC power to PoE+.

**Table 4 PoE Injector Type**

Outdoor AP	Aruba Part Number
AP-175	PD-9001G
MSR-2000	PD-9001G
MSR-4000	PD-9501G

## AC Power

AC is the most widely available power source on building rooftops. It is more expensive and time consuming to provision AC power compared to PoE+. An electrician must lay conduits and provision AC power next to the AP. Wiring used in outdoor deployments should be shielded. It is important to run outdoor wiring inside conduits to safeguard wires from external sources and keep every day wear-and-tear to a minimum.



AC power and Ethernet cable cannot be deployed in the same conduit due to interference issues.

## DC Power

DC power sources on building rooftops are not as pervasive as AC. DC-powered units are preferred for AP deployments that require solar power source because with DC-powered units, output from the battery can be used directly to power the DC APs.



Output from solar panel power is typically stored in a battery and in-turn the battery powers the AP directly. Output from battery can be 12V or 48V DC, depending on the battery design. Solutions with integrated PoE power are available as well.

Aruba Networks has worked with its partners to develop customized solar power panels to match the right power specification for its APs. A list of partners is available at <http://www.arubanetworks.com/aruba-partners/ecosystem-partners/enclosures-power-and-accessories/>.

## PoE Out Port

An AP that runs on AC or DC power provides support for a PoE out port. In many outdoor point-to-point deployments, video surveillance is a primary or a secondary requirement. A PoE out port that is built into the AP can be used to power PoE-capable devices, such as IP cameras.



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The PoE out port is available only on AC and DC versions of Aruba outdoor APs.

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## Wired Backhaul

Gateway APs in a mesh network have wired connections back to the data closet via Ethernet or fiber connections. Ethernet or fiber network backhaul typically is not included in the standard lease agreement. Therefore the organization that is deploying the mesh network has to pull in a DSL/T1 connection to each site that requires an Ethernet or fiber backhaul network. Larger companies simply work with cable or DSL providers who might have existing wiring connection in the building. Reduce the number of APs that require network backhaul to help save cost and time during deployment.



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Aruba AirMesh supports multiradio, multichannel architecture and typically requires fewer backhaul points compared to the standard ArubaOS mesh. This difference amounts to significant cost savings when you deploy networks that span many kilometers.

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## Legal

Site acquisition involves working with property owners or lease contractors who, in general, require that lease agreements be in effect before personnel can access their rooftops or the hardware can be deployed. Lease agreements are complex and it is best practice to have the Legal department involved early in the process to ensure that timelines are met and the process proceeds as expected.

## People and Resources

Outdoor mesh deployments are complex and time consuming. To save time and money, it is very important to get the right people involved. RF, electrical, computer networking, and project management expertise are all vital for successful completion of a point-to-point deployment.



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Outdoor deployment is an expensive undertaking and it is very important to get it right the first time. Redoing an existing deployment adds cost and time.

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## RF Engineer

Good RF LoS is a requirement for successful deployment of outdoor mesh networks. The key to attaining a good RF LoS is understanding the RF characteristics of each antenna and the antennas effects on long range links. The engineer must also have a good understanding the effects of terrain and environment factors where the AP and antennas are being installed. RF experts are responsible for picking the right antennas, mounting the APs, weatherproofing the APs, calculating the correct

mounting height for the antenna based on Fresnel zone clearance, and finally aligning the antennas for optimum RSSI levels and throughput performance.

## **Electrician**

Electrical work must be in place at each site where an AP is to be mounted. Power requirements vary depending on the type of AP and corresponding power source (PoE+, AC, or DC) being used. Project managers should work with the electricians to make sure that a reliable and constant power source is available at the AP mounting location to power the AP. In an outdoor deployment, all electrical equipment and wiring must be shielded and must be able to withstand the maximum high and low temperatures that are specific to the region. The electrician is responsible for installing lightning arrestors on each AP model. For more information about installing lightning arrestors, see the Installation chapter.

## **Network Engineer**

Network engineers provision backhaul connectivity for the mesh network and help project managers define the scope of the network. Typically, network engineers also manage the new outdoor mesh network when it is up and operational.

## **Project Manager**

The project manager manages the various resources involved in the project such as contractors. The project manager is responsible for procurement and overseeing installation. The project manager is also responsible for defining the project schedule and scope based on priorities after discussions with the team.



## Chapter 4: Installation

A successful installation requires attention to these elements:

- Staging
- Mounting APs and Antennas
- Choosing Antenna (RF) and Ethernet Cables
- Using Lightning Arrestors
- Using Paint for APs and Antennas
- Weatherproofing

### Staging

Before you begin an outdoor install, you must stage your equipment indoors. Staging is the process of making sure that all the equipment is ready, the configuration is right, and the setup works as intended before the APs and antennas are mounted on the poles or a rooftop. Unlike indoor deployments, mounting APs and antennas outdoors is expensive. Therefore it is important that everything works as intended before arrangements are made for professional services personnel to install the equipment.

The staging process includes these steps:

1. Unbox the AP and inspect it for any physical damage that might have occurred during transportation and storage. Physical damage to the APs must be addressed before the AP is mounted at the site.
2. Check that all other equipment including cables, tools, mounting systems, grounding systems is in place for the installation.
3. Use the quick start guide that was packaged with the AP hardware to configure the AP. For typical point-to-point setup, refer Chapter 4 in this guide for MeshOS configuration and Chapter 5 for ArubaOS configuration.

### Mounting APs and Antennas

Instructions for mounting APs and Antennas are included in the respective shipping box. You must follow the installation guide to ensure that the APs and antennas are mounted correctly. Customers with an Aruba support account can also find the hardware installation guide on the Aruba Support website.

After installing the APs and antennas on the rooftop or a light pole, ensure that the antennas are aligned correctly before climbing down the pole. In most cases, proper antenna alignment requires having good LoS between two end points.

Almost all point-to-point deployments use directional antennas. Always align the antenna while standing behind it as shown in [Figure 3](#). Ensure that you can clearly see the antenna at the other end is in line. Note that the beamwidths of the standard antenna offerings are large enough that “eyeballing” the link generally results in near optimal links.



**Figure 3**     *Antenna alignment*

## Choosing Antenna (RF) and Ethernet Cables

Currently, the Aruba price list has RF cables of four lengths (1 m, 2 m, 3 m, and 4 m). Cable loss should be accounted for at 7 dBm in 2.4 GHz and 10 dBm in 5GHz for every 100 ft of cable length.

Ethernet cables that are used in outdoor deployments must be shielded and outdoor rated, and they must be run inside a conduit up to the AP location. For distance greater than 80 meters, fiber cables should be used instead of Ethernet cables.



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AC power and Ethernet cable cannot be deployed in the same conduit due to line-cross issues.

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## Using Lightning Arrestors

Lightning arrestors should be used with all outdoor AP installations. The recommended lightning arrestor is available on the Aruba price list and its part number is AP-LAR-1. The device supports frequency ranges from 2 GHz to 6 GHz and therefore can protect wide range of devices operating at 2.4 GHz, 4.9 GHz, and 5 GHz. In the event of a lightning strike, a properly installed and grounded lightning arrestor acts as the first line of defense between the AP and the network devices connected at the data center.

Lightning arrestors must be installed between the AP and the RF cable that connects to the antenna and must be covered with weatherproof material as shown in [Figure 4](#). Lightning arrestors must be properly grounded. One lightning arrestor is required between each RF cable and AP connector. For example, the MSR4000 requires eight lightning arrestors to be connected between the eight connector ports and the respective active antennas. Lightning arrestors must also be weatherproofed.



**Figure 4**     **Lightning Arrestor**



**NOTE**

For instructions about installing lightning arrestors, refer to the installation guide provided in the hardware box.

## Using Paint for APs and Antennas

For aesthetic and security reasons, customers may want to paint the APs to blend in with their surroundings. Aruba 802.11n outdoor APs are designed to be painted with *non-metallic paint*. Only *non-metallic* paint does not affect the RF characteristics of the AP.



**Figure 5** AP and Antenna Painted

## Weatherproofing

It is highly recommended to weatherproof all connectors between the APs and antennas. Without water-tight weatherproofing on the connectors, APs and antennas are vulnerable to damage due to rain or other natural wear-and-tear.

Also the risks of not weatherproofing the equipment at the time of installation largely outweigh the costs and time needed to go back and fix the installation. The required materials for weatherproofing the AP connectors are available on the Aruba price list as a package. The part number for

weatherproofing kit is AINS2KKIT-00. The kit includes two electric tape rolls, one mastic tape roll, and tie wraps.

The weatherproofing tape must be wound very tightly over the connectors. Care should be taken to ensure that no areas around the edges are exposed. Take particular care around the corners and in between the connectors. For detailed information about weatherproofing, refer to the AP-175 installation guide on the Aruba support site. The AP-175 installation guide provides a step-by-step process for weatherproofing AP and antenna connectors. The MSR2000 and AP175 have the same connectors, so the same procedure can be used to weatherproof both AP models.



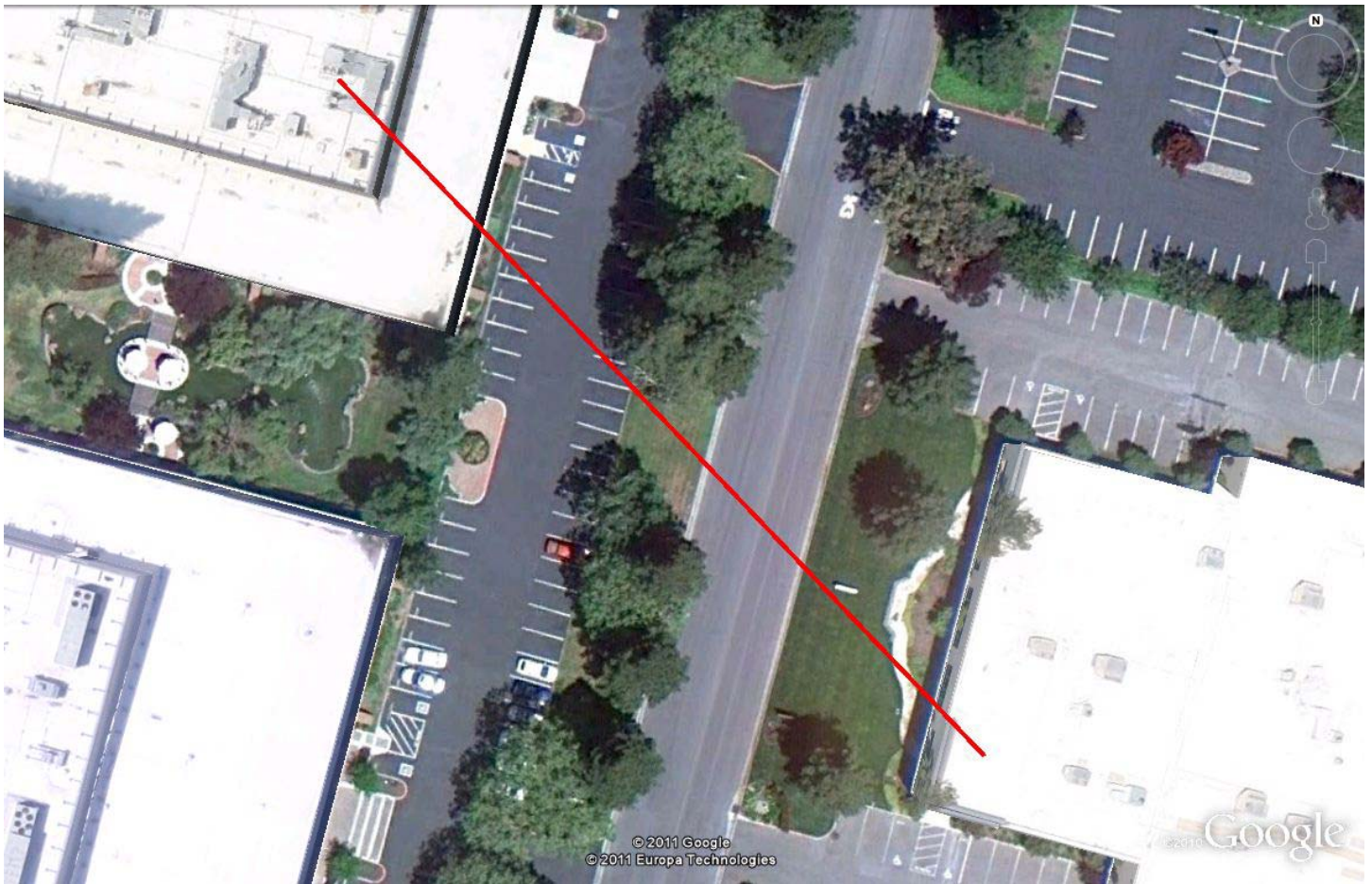
**Figure 6**      **Weatherproofing**



## Chapter 5: Point-to-Point Deployment Case Study

This case study steps through the decision making process and procedures considered for deploying a point-to-point mesh network at Aruba Networks headquarters. The purpose of this outdoor mesh deployment is to connect two separate buildings at the headquarters location, and saving money by not having to deploy fiber to the newer facility.

In an outdoor deployment, the project scope, cost, and timeline define the outcome of the project. The following sections describe the project scope and decision making process involved in selecting the right APs, antennas, and mounting gear.



**Figure 7** Google maps overview

### Project Motivation

**Problem Statement:** Two new buildings at the Aruba Networks headquarters locations need to be networked for LAN connectivity as quickly as possible. This network will be a production-grade network and must be able to handle minimum data transfer speeds up to 100 Mb/s (Fast Ethernet equivalent speeds). This network will be used only for backhaul, and client access is not a requirement. Clear LoS exists between the buildings, and we have rooftop rights on both buildings. The goal is to

connect the new building, which contains a lab, to the Aruba network headquarters at minimal cost and time. No fiber or existing cable connection between the two buildings.



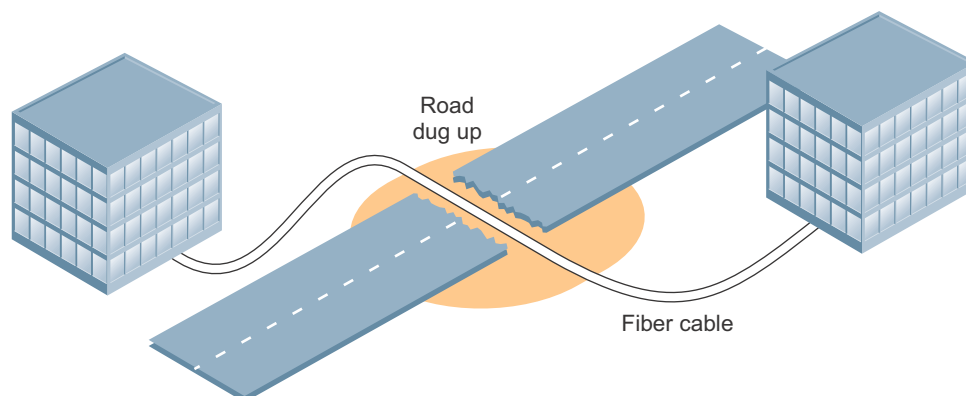
The scope of the project is the underlying assumption upon which all other factors in this case study are decided. The project manager should work with the network engineers and his team to help define the scope of the network and the application that will run on the network.

## LAN Connection Options

Each of the following connections was evaluated for this point-to-point deployment at Aruba Networks headquarters in Sunnyvale, California.

### Fiber Cable

Fiber is capable of carrying Gigabit (Gb/s) data traffic, which is far more than the required minimum data transfer of 100 Mb/s for this project. However, the cost of digging under municipal roads and laying fiber underground far exceed the budget allocated for the project. To lay underground fiber cables between two buildings, you must obtain additional approvals from legal and the local municipal office, which is a long and time-intensive process.



**Figure 8** *Fiber connection between two buildings*

### Carrier VPN

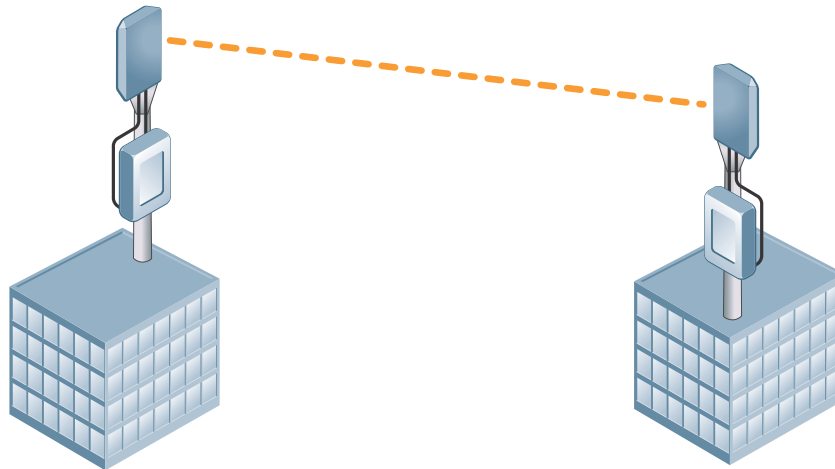
Telco and cable operators can provide connectivity between the two buildings, but after investigating this option, the total estimated cost far exceeded the budget for this project. Leasing network bandwidth from a telco is the least preferred choice for connecting two buildings within a campus because the cost per gigabit ratio is very high and it is a recurring cost.

**Table 5** **LAN Connection Cost**

Deployment Type	TCO
Fiber cable	\$\$\$
Carrier VPN	\$\$\$\$\$ (recurring cost)
Wireless mesh	\$

## Wireless Mesh

With 802.11n technologies, Wi-Fi-based mesh networks are capable of transfer speeds up to 160 Mb/s, which is well within the requirements of this project. In this project, deploying a point-to-point outdoor wireless mesh was a straight-forward choice as there is no T1 or fiber cable currently connecting the two buildings. New fiber cables would have to be run underground, which is not a feasible option, given the cost and time frame of this project.

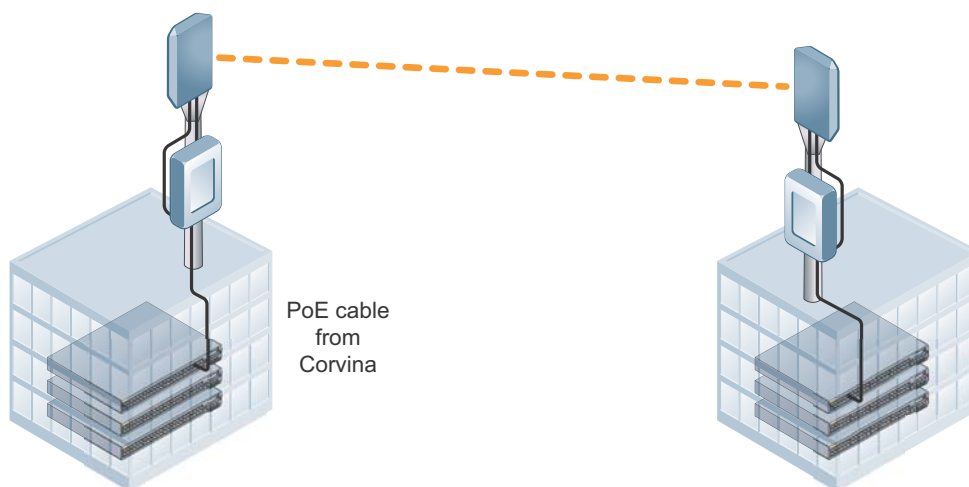


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**Figure 9** *Point-to-point wireless backhaul*

## Network Diagram

Figure 10 shows the network diagram of the point-to-point mesh setup at headquarters. Existing S3500 PoE switches available in the Aruba data closet are used to power the mesh APs. The S3500 switch provides LAN networking for respective buildings. When the outdoor mesh network is set up, a single Layer 2 network connection is established between two buildings over mesh.



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**Figure 10** *Network Setup*

## Power Options

APs on both building rooftops are powered using PoE+. In a point-to-point deployment like this one, both APs are wired back to network closets. Aruba IT owns access to network closets in both the buildings and the overall cable length is short, so it is much easier and cost-effective to use PoE+ to power the APs. With PoE+ power, no electrician is needed to provision AC outlets on the rooftop to power the APs.



Only shielded or outdoor-rated Ethernet cable must be used in outdoor deployments. Also, the cable must be run inside a conduit as shown in [Figure 11](#). Using shielded cable and running it inside a conduit ensures that the cabling is protected from damage that might occur from extreme temperatures.



**Figure 11**     *Cables in the conduit*

## Selecting the Correct AP and Antennas

Selecting the correct APs and antennas can mean the difference between success and failure for an outdoor mesh deployment. The AP functionality and control should match the deployment model. To align the antenna correctly the first time, you must have a good understanding of the different antenna patterns and mounting positions.

### APs

ArubaOS and MeshOS run on two different hardware platforms. The following section will help you make the right AP choice.

### ArubaOS vs. MeshOS

Aruba Networks has two different operating systems and both are capable of wireless mesh networking. ArubaOS powers the standard controller and light-weight outdoor APs, such as AP-175. MeshOS takes an autonomous AP approach and is designed to take full advantage of the hardware-supported multiradio architecture capabilities. [Table 6](#) compares the ArubaOS and MeshOS options.

**Table 6 ArubaOS and MeshOS Comparison**

Comments	ArubaOS	MeshOS
Controller-based architecture (tree-based forwarding)	✓	-
Distributed architecture (Layer 3 routing)	-	✓
RF optimization and client visibility features with RF protect	✓	✗
Amigopod integration for advanced guest access	✓	✗
Strong backhaul capabilities with fast link convergence	✗	✓
Multiradio, multiband backhaul capabilities	✗	✓
Seamless integration with the AirWave Management System	✓	✓

### Product Selection

Use certain criteria to pick the right product for the project. These questions will help you choose the correct Aruba AP based on your project requirements:



These questions are not specific to point-to-point deployments. They can be used to pick the right APs for all types of point-to-point, point-to-multipoint, or true mesh outdoor deployment.

- Will this deployment be used primarily for network backhaul or access?

For point-to-point deployment at Aruba HQ, the primary use case is backhauling network traffic from the data center in one building to data closet in another.

- Is it a standalone network deployment or is this network an addition to the existing controller based solution?

For this project, the network needs to be standalone. Aruba IT personnel did not want the network to be completely integrated with its existing indoor WLAN network, but still required it to be managed by using the existing AirWave network management system.

- What is the scale of the project? What is the gateway-to-node ratio?

APs running on ArubaOS and MeshOS can scale over multiple square kilometers. However, to recommend the right product based on project scale, it is more important to know what the ratio of gateways to mesh nodes is. The number of wired (egress) connections required per mesh group to sustain the guaranteed project bandwidth requirements is known as the gateway-to-mesh node ratio. APs running MeshOS, due to distributed and multiradio architecture, require fewer egress connections per mesh node compared to APs that run ArubaOS.

The ratio between wired nodes vs. mesh nodes is not pertinent to this point-to-point deployment because both ends of the mesh network are connected to network wiring closets in their respective buildings.

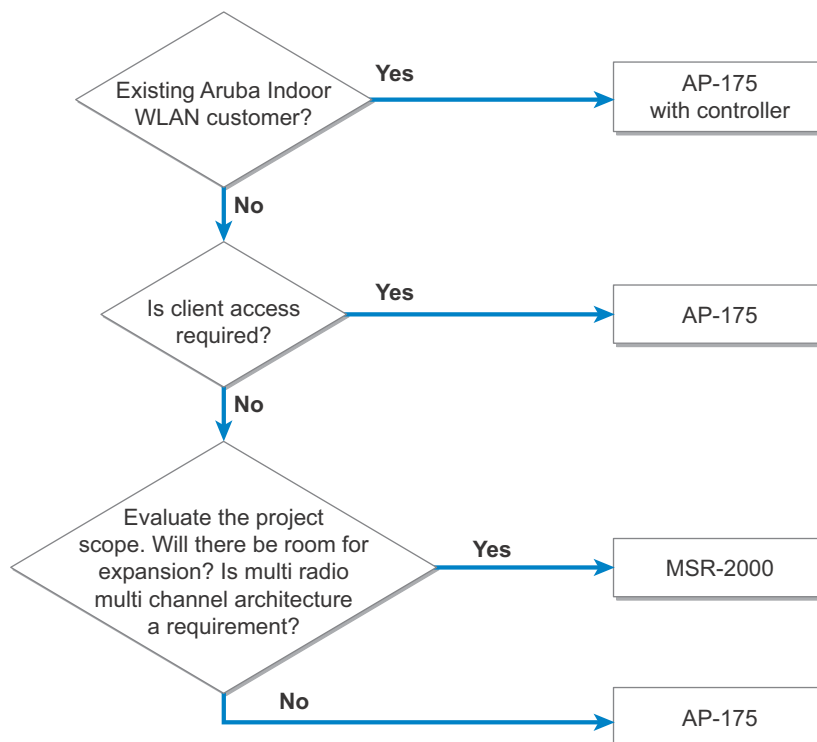
- Is there a need for a multiradio, multichannel architecture?

This deployment is a point-to-point deployment, so clearly there is no immediate need for multiradio, multichannel architecture. However, this architecture may be a nice future-proof investment in the event that Aruba IT decides to scale up the mesh network to interconnect additional buildings in the campus.

These questions and the flowchart in [Figure 12](#) should help you select the right AP for all backhaul applications.



Aruba AP MSR2000 or AP175 could have been used for this point-to-point deployment at HQ. MSR2000 was chosen based on project requirements.



arun\_0538

**Figure 12** Decision tree to select APs for a point-to-point deployment

## Antennas

The correct antenna is just as critical as the right AP for successful completion of outdoor wireless mesh networks. The wide range of Aruba outdoor antennas take full advantage of the new MIMO functionalities by utilizing specially designed cross-polarized MIMO antennas that are compatible with all new 802.11n APs.

Antenna gain and antenna beam patterns are two important factors that dictate the type of antenna needed for the deployment.



---

Antenna gain is passive gain. The antenna does not add extra power; rather it is either simply redistributed or concentrated.

---



---

Carefully read safety instructions in the antenna hardware installation guide before you connect it to the AP.

---

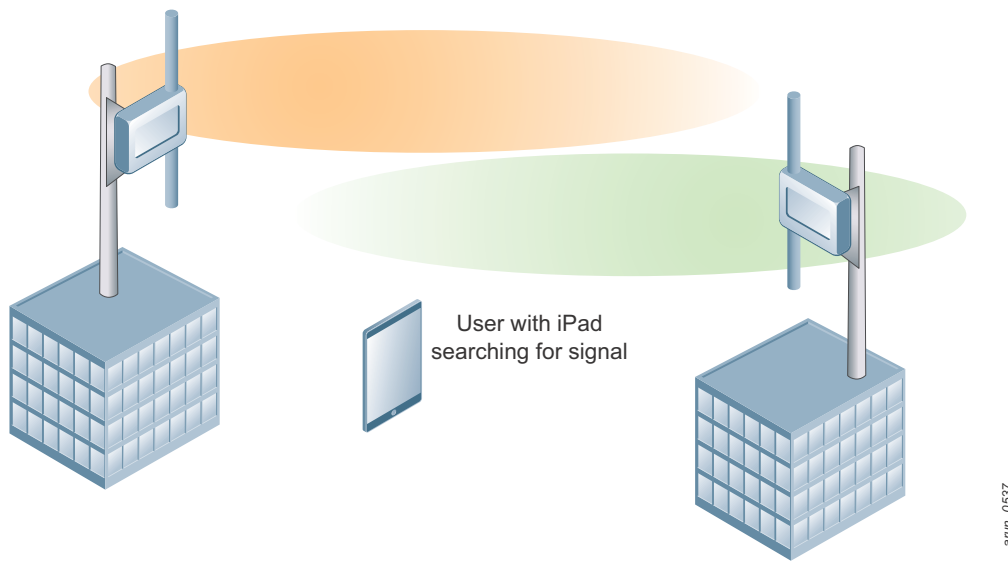
If you understand antenna RF characteristics and the supported frequency ranges, you can pick the right antennas for each deployment. To understand antenna characteristics, familiarize yourself with the following terms.

### Supported Frequency Range

The antennas on the Aruba price list currently support different frequencies bands (2.4 GHz, 5 GHz, and 4.9 GHz). Before you decide on a particular antenna type, make sure that it supports the frequency bands required for the project.

## E-Plane

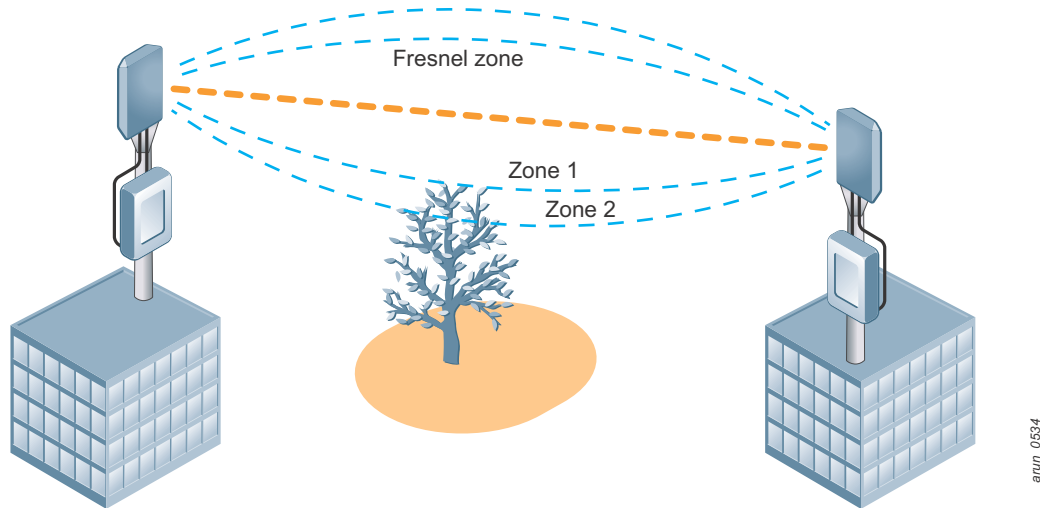
In a dual-polarized antenna, the E-plane represents the vertical beamwidth of the antenna in degrees. Choosing the right beamwidth depends on requirements. For example, omnidirectional antennas with high gain have a very small E-plane. This is not necessarily bad and sometimes is a requirement depending on the deployment type. A small E-plane means that mounting height becomes a critical factor. At short distances, installing an antenna with a small E-plane increases the complexity in antenna alignment. RF installers must ensure that the antenna heights and alignment between two the endpoints are correct. Incorrect antenna height or alignment results in poor RSSI values and weak links between two mesh points because the signal from one antenna will be shot over or under the other antenna.



**Figure 13** *Poor RF planning using omnidirectional antennas*

## H-Plane

In a dual-polarized antenna, the H-plane represents the horizontal beamwidth of the antenna in degrees. Very high-gain directional antennas have extremely small H-planes. RF installers must understand these characteristics to help align an antenna between two endpoints correctly.



**Figure 14** *Fresnel zone*

Fresnel calculations: The Fresnel zone is the minimum unobstructed path required between two point-to-point links for successful transmission of RF signal. Fresnel zone is divided into multiple zones as shown in Figure 14. Zone 1 is the inner-most Fresnel zone and for a point-to-point mesh link to be stable and working, maximum Fresnel zone obstruction should not exceed 20% in Zone 1. RF LoS can be validated easily by monitoring the Receive Signal Strength Indication (RSSI) value at each end of the point-to-point link at the respective AP.

$$r_{\text{meters}} = 17.32 \times \sqrt{\frac{d_{\text{km}}}{4f_{\text{GHz}}}}$$

$d$  = Distance between two mesh nodes  
 $f$  = Operating frequency

**Figure 15** *Fresnel zone calculations*

For point-to-point deployment, it is best to choose a directional antenna that can operate in 5 GHz with 20 to 60 degrees H-plane and 10 to 20 degrees in the E-plane. The Aruba antenna that fits these criteria is the AP-ANT-5614.

**Table 7 Aruba 5 GHz Directional Antennas**

Part Number	Description
ANT-2x2-5614	4.9-5.9GHz, 14.0dBi, 60°, ±45° polarized two-element MIMO high-gain directional panel antenna, 2x N-type female connectors. Cables <i>not</i> included.

A large H-plane and E-plane provides the flexibility in antenna alignment. For the point-to-point deployment at headquarters, the AP-ANT-5614 antenna is the choice due to its high gain (14dbi) and large H-plane (60 degree).

## Bill of Materials

Table 8 shows the completed bill of materials for a point-to-point outdoor deployment.

**Table 8 Case Study Bill of Materials**

Part Number	Description	Quantity
MSR2K23N0-US	MSR2000, dual 2x2 320mW; POE; US	2
AFC7DL01-00	7D antenna cable with two N-type male connectors, 1 meter	4
ANT-2x2-5614	4.9-5.9 GHz, 14.0 dBi, 60°, ±45° polarized two-element MIMO high-gain directional panel antenna, 2x N-type female connectors. Cables <i>not</i> included.	2
PD-9001G-AC	1 Port 802.3at PoE Midspan 10/100/1000 30W	2
AINS2KKIT-00	Outdoor Installation Materials. Includes accessories that may be useful in the installation process: two electrical tape rolls, mastic tape, and white tie wraps	4
AP-LAR-1	Aruba Outdoor Antenna Lightning Arrestor for outdoor APs: single, in-line lightening arrester with N-type male to N-type female interface. Supports RF frequency pass-through of 2 – 6 GHz.	4

## Chapter 6: MSR2000 Setup, Configuration, and Validation

In a point-to-point deployment using MSR2000, only one of the two software-configurable radio cards that are built into the MSR2000 are used. This guide is written under the assumption that only “Radio 0” is used for mesh links and “Radio1” is disabled. Follow the steps in this chapter to set up a simple point-to-point configuration.



---

This chapter provides the steps to configure a point-to-point mesh link quickly. For complete details about designing a mesh network to fit your project requirements, refer to the *MeshOS User Guide*.

---

### MeshOS Initial Setup

A new MSR product does not have an IP address assigned to it. To establish a Telnet connection to the AP, it needs an IP address. The two ways to obtain an IP address for the MSR product are these:

- DHCP assignment: Connected to a DHCP server, the MSR product can assign an IP address to the box dynamically. The IP address assigned to the AP can be monitored at the DHCP server.
- Manual assignment: IP addresses can be set up manually at each box through console access. Typically point-to-point deployments are considered a small-scale mesh deployment and therefore the DHCP server is not necessarily found or used, especially for deployments that are independent of rest of the network. For instructions about console access and static IP address assignment, refer to the quick start guide. The quick start guide is available on the Aruba support site for customers with support accounts.

After you have assigned an IP address to the box, open the web browser of your choice, and type in the statically assigned IP into the address field. If the connection is successful, you are prompted for username and password. The default username is **root** and the password is **public**.




---

Ensure that your laptop is on the same IP subnet and is directly connected to the AP by an Ethernet cable.

---

On the system information page, under Software Status, check for the MeshOS version number. The current version of MeshOS is 4.2. For best performance, ensure that you have the current version of MeshOS running. [Figure 16](#) shows a typical software status page for an MSR2000.

# MSR2000



Menu

- > System Information
- > Basic Settings
- > Wired Settings
  - > Ethernet
- > Wireless Settings
  - > Radio
  - > BSS
  - > Mesh
  - > Client Mode
- > Network Settings
  - > Routing
    - > Static Routes
    - > OSPF
    - > AWR
    - > Multicast
  - > DHCP
    - > DHCP Server
    - > DHCP Relay
  - > VLAN
  - > Loopback
  - > NTP
- > Services Settings
  - > Mobility
  - > VPLM
  - > Auto Recovery
  - > AVT

⇒ Home Page

## Device Information

Model	MSR2000
Serial Number	26A02103800012
Software Version	4.2
Hardware Version	A0
MAC Address	00:17:7b:2c:61:c3

## Running Status

CPU Usage	4%
Memory	126572KB Total, 58268KB Free
Storage	3392KB Total, 2644KB Free
Up Time	03:37:34
NTP Server	Unconfigured

## Software Status

Running Version	
Version	4.2
Create Time	2011/04/27 18:00
Type	Official Release
Stored Version	
Status	[Running]
Version	4.2
Create Time	2011/04/27 18:00
Type	Official Release

**Figure 16 MeshOS Device Information and OS Version**

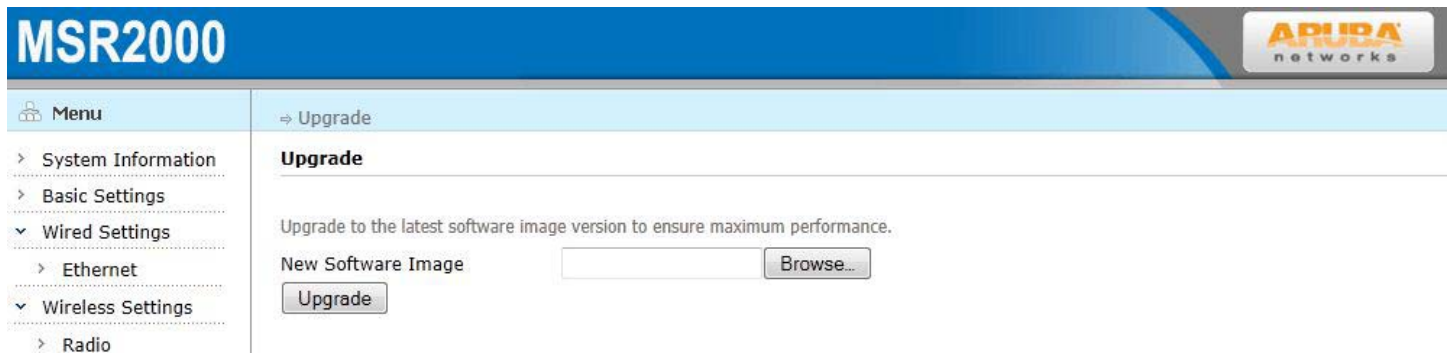


NOTE

The current version of MeshOS is available on Aruba support site for customers with existing support accounts. Contact your Aruba sales representative if you do not yet have a support account with Aruba Networks.

To upgrade software:


- In the left column, click **Upgrade** in the Maintenance section.
- Click **Browse** and find the OS image you just downloaded from Aruba support as seen in [Figure 17](#). Click **Upgrade**. In few minutes, your AP will reboot and will be upgraded to the current MeshOS code base.




**Figure 17**     *MeshOS Upgrade page*

- Next you must configure some basic settings for the AP. In the left column, click **Basic Settings** as seen in [Figure 17](#).
- Regulatory Domain: Regulatory Domain should be set to the country that AP will be operating in. This configuration is important because regulatory information such as maximum EIRP is calculated automatically using the regulatory domain setting as the reference source.
- Installation Type: Aruba outdoor APs can operate indoors as well as outdoors depending on specific customer deployments. However certain regulatory bodies mandate appropriate use of channels for indoor and outdoor use. Therefore the correct installation type must be selected depending on the deployment. Operating channel is automatically provisioned depending on the installation type.
- Host Name: It is best practice to use a host name to clearly identify the AP being deployed. The host name can represent AP location, AP use case, or just follow a numbering scheme. Examples of valid host name values are AP-HQ, AP-Mesh, or AP-1.

MSR2000



 **Menu**

- > System Information
- > Basic Settings
- ▼ Wired Settings
  - > Ethernet
- ▼ Wireless Settings
  - > Radio
  - > BSS
  - > Mesh
  - > Client Mode
- ▼ Network Settings
  - ▼ Routing
    - > Static Routes
    - > OSPF
    - > AWR
    - > Multicast
  - ▼ DHCP
    - > DHCP Server
    - > DHCP Relay
  - > VLAN
  - > Loopback
  - > NTP
- ▼ Services Settings
  - > Mobility
  - > VPLM
  - > Auto Recovery

⇒ Basic Settings

### Basic Settings

This section contains basic and common settings of the device.

Regulatory Domain	<input type="text" value="United States"/>	
Installation Type	<input type="radio"/> Indoor <input checked="" type="radio"/> Outdoor	Need reboot for this change to take effect
Host Name	<input type="text" value="AP-1341"/>	Device's hostname (up to 32 characters)
Location Info		
Longitude	<input type="text"/>	Longitude of the Device in DMS (Degrees,Minutes,Seconds), format. Example: 122 02 34.29 W (DDD MM SS.SS D).
Latitude	<input type="text"/>	Latitude of the Device in DMS (Degrees,Minutes,Seconds), format. Example: 37 22 08.75 N (DD MM SS.SS D).
Altitude	<input type="text"/>	Altitude of the Device in decimal format. [-10000..10000] meter.
Management IP Address		
<input type="radio"/> Use DHCP		
Vendor ID	<input type="text"/>	DHCP option 60(optional, up to 64 characters)
<input checked="" type="radio"/> Static IP/Mask	<input type="text" value="192.168.254.1/24"/>	Format: A.B.C.D/M
<input type="radio"/> Do not configure		
Telnet Access	<input checked="" type="radio"/> Disabled <input type="radio"/> Enabled	

**Figure 18     MeshOS Basic Settings page**

The next step is to configure radio cards for point-to-point mesh backhaul. Follow these steps:

- In the left column, click **Wireless > Radio**.
- Click the **Basic** tab. You will see the screen in [Figure 19](#).
  - Set Mode/Channel to **802.11na 40Mhz Plus**.
  - Set Antenna Gain to **14**.
  - Set TX Power to **0**.
- Click **Apply Changes**.



Gain values on all Aruba certified antennas are available on the data sheet. ANT-5614 used on this deployment has gain value of 14 dB.



Although TX Power is set to 0, MeshOS intelligently optimizes the transmit power based on antenna gain and total EIRP allowed for the specific region.

**MSR2000**

Menu

- System Information
- Basic Settings
- Wired Settings
  - Ethernet
- Wireless Settings
  - Radio
  - BSS
  - Mesh
  - Client Mode
- Network Settings
  - Routing
    - Static Routes
    - OSPF

Wireless Settings > Radio > Radio Configuration > Basic

**Radio Configuration**

Configure Radio Port Settings.

Basic Backhaul Advanced

Radio Index: 0

Mode/Channel: 802.11na 40Mhz Plus (157 (5.785GHz, 40MHzBandwidth))

Antenna Gain (db): 14 [0..255]

TX Power (dBm): 0 [0..50], 0 for uncontrolled

Admin Status: Up

Apply Changes Cancel Changes

**Figure 19** Wireless Basic settings

Next click the **Backhaul** tab as seen in [Figure 20](#):

- Enable Auto WDS Meshing. Auto WDS Meshing must be **enabled** for that radio card to operate in backhaul mode. If Auto WDS Meshing is not enabled, that radio card will not mesh with any other AP even if all the APs have same mesh ID and correct password settings.
- Set Max Allowed Links to **1**. Max Allowed Links represents the number of links each radio can use to mesh with other APs in its RF vicinity. Sometime even with directional antennas, an AP might see one or more mesh APs. Max Allowed Links can be used to reduce the number of mesh links each radio forms. MeshOS allows a maximum of six WDS links per radio.
- Click **Apply Changes**.

The screenshot displays the Aruba MSR2000 WebUI interface. The top header is blue with 'MSR2000' on the left and the 'ARUBA networks' logo on the right. Below the header is a navigation bar with a 'Menu' icon and a breadcrumb trail: '⇒ Wireless Settings > Radio > Radio Configuration > Backhaul'. On the left side, there is a 'Menu' section with a tree view containing: 'System Information', 'Basic Settings', 'Wired Settings' (with a sub-item 'Ethernet'), 'Wireless Settings' (expanded, with sub-items 'Radio', 'BSS', 'Mesh', and 'Client Mode'), 'Network Settings', and 'Routing'. The main content area is titled 'Radio Configuration' and includes the instruction 'Configure Radio Port Settings.'. It features three tabs: 'Basic', 'Backhaul' (which is selected and highlighted in blue), and 'Advanced'. Under the 'Backhaul' tab, the following settings are visible: 'Radio Index' set to '0', 'Auto WDS Meshing' with 'Enabled' selected (indicated by a blue dot), and 'Max Allowed Links' set to '1' via a dropdown menu. At the bottom of the settings area are two buttons: 'Apply Changes' and 'Cancel Changes'.

**Figure 20**      **Wireless Backhaul settings**

Next, click the **Advanced** tab as seen in [Figure 21](#):

- Set Channel Policy to Auto: Channel Policy must be set to **Auto**. MeshOS has built-in spectrum analysis that periodically scans for the best available channel and ensures that the channel with minimum interference is chosen.
- Enable Short GI: Short GI must be **enabled** for all point-to-point links. To improve throughput, the 802.11n standard has provisos to reduce the guard interval timer from 800 nanoseconds to 400 nanoseconds. This can be achieved by enabling short GI.
- Max Neighbor Distance: Max Neighbor Distance must be set up for links greater than 1000m. For links ranging 1000m to 8000m, a 10% buffer must be added to the total distance value between two point-to-point links. For links greater than 8000m, the distance value buffer must be at about 20%. For example, if the distance between two point-to-point links is 4000m, the Max Neighbor Distance should be set at 4400 m.
- Click **Apply Changes**.

**MSR2000** ARUBA networks

Menu ⇒ Wireless Settings > Radio > Radio Configuration > Advanced

### Radio Configuration

Configure Radio Port Settings.

**Basic** **Backhaul** **Advanced**

Radio Index	0	
Channel Policy	Auto ▾	
Channel Selection Interval (m)	0	[0..6000], Valid only for automatic channel policy, and 0 for no repeated selection
Channel List		Channel list seperated with comma. e.g. 1, 3-5, 7 Channel list seperated with comma. e.g. 36, 60, 100, 149
802.11bg		
802.11a		
Max Neighbor Distance (m)	0	[0..50000], and 0 for unset.
CTS Protection	Disabled ▾	
Beacon Interval (ms)	100	[100..1000]
Preamble Mode	Long ▾	
Short GI	Enabled ▾	

**Apply Changes** **Cancel Changes**

**Figure 21**      **Wireless Advanced settings**

Next, in the left column, click **Wireless Setting > Mesh**.

Click the **Basic** tab as seen in [Figure 22](#):

- Enter a Mesh Network ID. The Mesh Network ID must match across all APs operating under the same mesh network.
- Set the WDS IP pool to be automatically generated from MAC.

The underlying architecture for MeshOS is always Layer 3 and therefore each mesh AP on the network must have an IP address. This IP address can be statically assigned to each AP or the AP can automatically generate an IP from its MAC address. WDS IP is not referenced in any configuration setup and it is purely used for internal communication, so it is recommended that you set WDS IP pool to be generated from MAC.

- Click **Apply Changes**.



For complete information about Mesh Network ID and WDS IP Pool, refer to the MeshOS user guides posted on the Aruba support site.

**Figure 22**      **Wireless Mesh Basic settings**

Click the **Security** tab as seen in [Figure 23](#).

- Set Security Type to **WPA2**. Aruba supports all security standards. It is the recommended practice to set WPA2 for backhaul links.
- Enter a security key that is 8-63 characters long. The security type and string must match across both mesh APs in a point-to-point deployment.
- Click **Apply Changes**.



Please refer to MeshOS user guide for supported security standards.

**Figure 23**      **Wireless Mesh Security settings**

Virtual Private LAN Mesh (VPLM) is the Aruba-proprietary implementation of Layer 2 over core Layer 3 routing architecture.

To enable VPLM, go to **Service Settings > VPLM** as shown in [Figure 24](#).

- Ensure the VPLM is **enabled**.
- Click **Apply Changes**.



For more information about VPLM, refer to the *MeshOS User Guide*.

**MSR2000** **ARUBA networks**

Menu

- System Information
- Basic Settings
- Wired Settings
  - Ethernet
- Wireless Settings
  - Radio
  - BSS
  - Mesh
  - Client Mode
- Network Settings
  - Routing

⇒ Services Settings > VPLM

### VPLM

Configure Virtual Private Lan over Mesh (VPLM) to enable layer-2 serves over the wireless mesh network

Status: Enabled

Allowed VLAN:  
☒ Auto  
☐ Manual

Spanning Tree Compatibility: Disabled

A list of allowed VLAN numbers between 1-4094; use comma to separate multiple VLANs or VLAN ranges; e.g. 10,20,30,40-50, with no whitespace

Apply Changes

**Figure 24** **VPLM Services Settings page**

It is best practice to change the Aruba default password to your AP box as shown in [Figure 25](#).

Go to **Maintenance > Password**.

- Enter the old password. Default password on the box is `public`.
- Enter the new password.
- Re-enter the new password in next field.
- Click **Apply Changes**.

**MSR2000** **Aruba networks**

Menu Maintenance > Password

**Change Password**  
Change the password for logging onto this device.

Username root

Old password

New password  String length 1-32, cannot include blank

Re-enter New password

Apply Changes

**Figure 25** *Change AP password*

You have now set up one of the two APs required for a point-to-point link. To setup the second AP, repeat this procedure on the second AP.

## Validate Mesh Point-to-Point Connections

Now that you have set up both APs for point-to-point links, you must validate that the APs are configured correctly and able to mesh before mounting them to the pole. To ensure mesh connectivity between two APs in a staged bench setup:

1. Bring up both APs using PoE+ injectors.
2. Connect your laptop to root AP1.
3. Open a web browser and go to the IP address of AP1.
4. Login using your AP credentials.
5. Go to **Troubleshooting > Tools**
6. Next to RF Management, click **Execute** and select **Active Links** from the menu.
7. Wait for the AP to execute the command.

You will now see one active link between AP1 and AP2 as shown here:

### AP1:

```
Radio 1 Wireless mode:na, Wireless channel:165
Link 0: Peer hostname: Node-2,
Peer radio index: 1, Peer MAC: 00:17:7b:2a:6c:58,
Local role: ap, Local interface name: dot11radio 0/wds 0,
Local IP: 21.171.22.129, Peer IP: 21.171.22.130,
Link state: physical up, Physical up time: 0:1:26,
Data rate: 130M, RSSI: 92, SNR: 92,
Input rate: 2.87 Kbps, Output rate: 14.48 Kbps.
```

## Chapter 7: AP-175 Setup, Configuration, and Validation

This chapter will help you set up point-to-point mesh links using an Aruba controller-based outdoor AP such as the AP-175. To set up point-to-point network using MSR routers, refer Chapter 4.

This guide assumes that you have access to an Aruba controller and can successfully login to the controller with administrative rights. If you need assistance setting up your new Aruba controller from factory settings, refer to the [Aruba quick start guide](#), which is available on the Aruba support site.



The configuration and setup information in this chapter are specific to point-to-point deployments. Refer to the Aruba user guide for complete information on setting up Aruba controller, available at <https://support.arubanetworks.com>.

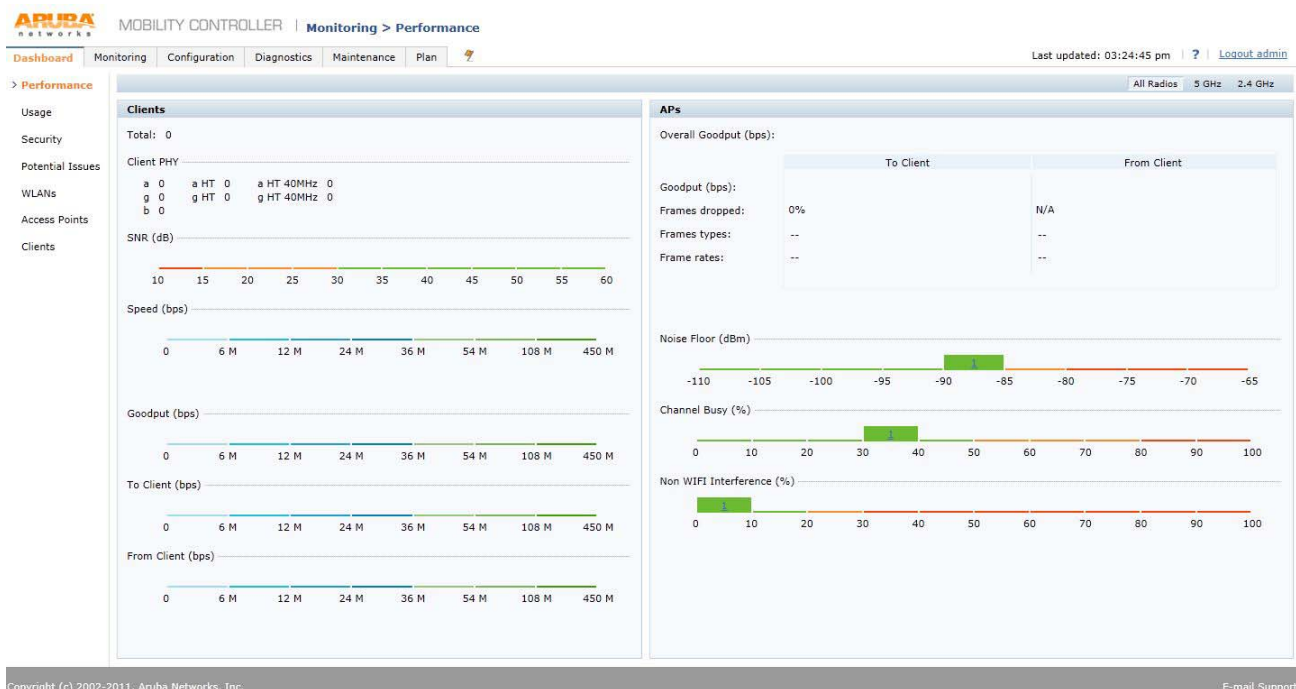


Click **Apply** whenever a value is changed in the GUI.



Applying the configuration implements the changes only temporarily but these changes are not saved through a reboot. To save these changes, click **Save Configuration** at the top of the screen ([Figure 27](#)).

- Login to your Aruba controller using a web browser (Internet Explorer, Firefox, or Safari).
- The home screen is displayed as shown in [Figure 26](#).



**Figure 26** Aruba Controller 6.1.1.0 home screen

- Create a new AP group as shown in [Figure 27](#). In this example, the AP group name is “Mesh”.



Configuration profiles can be applied to the entire AP group or to each individual AP. AP groups must be set up before profiles can be configured to the entire group.



To change group settings create a new AP group rather than modify the default AP group. This preserves the default group settings.



**Figure 27** New AP Group page

Next configure each radio profile for the following AP group. After the AP group is configured with correct radio profiles, the AP is placed in the correct AP group.



Click **Apply** whenever a value is changed in the graphical user interface (GUI).



Applying the configuration implements the changes only temporarily, but these changes are not saved through a reboot. Click **Save Configuration** at the top of the screen to save these changes.

- Edit the AP group “Mesh” to make changes to these properties:
  - RF management: The RF management radio profile contains configuration parameters to set up RF profiles for 802.11a and 802.11bg radios. You will be setting up point-to-point link using 5 GHz, and therefore the 2.4 GHz radio will be disabled.
  - AP: The AP profile contains the wired AP parameters. Wired AP parameters refer to Ethernet ports on each Aruba AP.
  - Mesh: The Mesh profile contains all mesh parameters necessary to set up a secure enterprise mesh using an Aruba controller.

To configure the radio profiles for the newly created AP group **Mesh** as shown in [Figure 28](#):

- Expand RF Management by clicking the + sign next to it.
- Click the 802.11a radio profile configuration.
- Create a new 802.11a radio profile. This example uses “5GHz-Mesh” as the 802.11a radio profile name.
- Ensure that **Radio enable** is checked (default).
- Ensure that **High throughput enable (radio)** is checked (default).
- Ensure that Transmit EIRP is set to **36 dBm**, which is the maximum setting for this parameter. The actual EIRP will be adjusted to be the maximum allowed based on the configured country code. ArubaOS optimizes the EIRP based on the regulatory settings that are specific to the country where the AP is operating.
- Ensure that the Maximum Distance parameter is set correctly in meters. The Maximum Distance parameter should be 2 times the actual distance.
- Ensure that a static channel is set as shown in [Figure 28](#). Only channels that are certified for outdoor use can be used. UNII-1 channels cannot be used outdoors.

### Edit 802.11a radio profile

```
rf dot11a-radio-profile "5GHz-Mesh"
  channel 149+
  tx-power 36
  no spectrum-load-bal-domain
  maximum-distance 30
ap-group "Mesh"
  dot11a-radio-profile "5GHz-Mesh"
```

Profile Details			
<b>802.11a radio profile &gt;</b>			
--NEW--		5GHz-Mesh	
Radio enable	<input checked="" type="checkbox"/>	Mode	ap-mode
High throughput enable (radio)	<input checked="" type="checkbox"/>	Channel	149 Secondary Channel: <input type="radio"/> None <input checked="" type="radio"/> Above <input type="radio"/> Below
Beacon Period	100 msec	Beacon Regulate	<input type="checkbox"/>
Transmit EIRP	36	Advertise 802.11d and 802.11h Capabilities	<input type="checkbox"/>
Spectrum load balancing	<input type="checkbox"/>	Spectrum Load balancing mode	channel
Spectrum load balancing update interval (sec)	30 seconds	Spectrum load balancing threshold (%)	20 percent
Advertized regulatory max EIRP	0	Spectrum Load Balancing domain	
RX Sensitivity Tuning Based Channel Reuse	disable	RX Sensitivity Threshold	0 -dBm
Non 802.11 Interference Immunity	Level-2	Enable CSA	<input type="checkbox"/>
CSA Count	4	Management Frame Throttle interval	1 sec
Management Frame Throttle Limit	20	ARM/WIDS Override	<input type="checkbox"/>
Maximum Distance	30 meters		

**Figure 28 Edit 802.11a radio profile**

Within the 802.11a profile, the ARM profile needs to be set. Follow these steps to create a new ARM profile:

- Create a new ARM profile. In [Figure 29](#) the profile is called “Disable”.
- Set the ARM channel assignment to **disable**.

### Configure 802.11a radio profile

```
rf arm-profile "disable"
  assignment disable
rf dot11a-radio-profile "5GHz-Mesh"
  arm-profile "disable"
```

Profile Details			
<b>Adaptive Radio Management (ARM) Profile &gt;</b>			
--NEW-- ▾		disable	
Assignment	disable ▾	Allowed bands for 40MHz channels	a-only ▾
Client Aware	<input checked="" type="checkbox"/>	Max Tx EIRP	127 ▾
Min Tx EIRP	9 ▾	Multi Band Scan	<input checked="" type="checkbox"/>
Rogue AP Aware	<input type="checkbox"/>	Scan Interval	10 sec
Active Scan	<input type="checkbox"/>	Scanning	<input checked="" type="checkbox"/>
Scan Time	110 msec	VoIP Aware Scan	<input type="checkbox"/>
Power Save Aware Scan	<input checked="" type="checkbox"/>	Video Aware Scan	<input checked="" type="checkbox"/>
Ideal Coverage Index	10	Acceptable Coverage Index	4
Free Channel Index	25	Backoff Time	240 sec
Error Rate Threshold	50 %	Error Rate Wait Time	30 sec
Noise Threshold	75 -dBm	Noise Wait Time	120 sec
Minimum Scan Time	8	Load aware Scan Threshold	1250000 Bps
Mode Aware Arm	<input type="checkbox"/>		

**Figure 29**     **Configure 802.11a ARM Profile**

- Disable the 2.4 GHz radio as shown in [Figure 30](#):
  - In point-to-point deployments, disable 802.11g radios.
  - Under 802.11g radio profile, create a new profile called “disable”.
  - Uncheck the **Radio enable** box under the 802.11g profile name.

### Disable 802.11g Radio

```
rf dot11g-radio-profile "disable"
  no radio-enable
  no channel
  no spectrum-load-bal-domain
ap-group "Mesh"
  dot11g-radio-profile "disable"
```

Profile Details			
802.11g radio profile > disable ▾		<a href="#">Show Reference</a> <a href="#">Save As</a> <a href="#">Reset</a>	
Radio enable	<input type="checkbox"/>	Mode	ap-mode ▾
High throughput enable (radio)	<input checked="" type="checkbox"/>	Channel	<input type="text"/> Secondary Channel: <input checked="" type="radio"/> None <input type="radio"/> Above <input type="radio"/> Below
Beacon Period	<input type="text" value="100"/> msec	Beacon Regulate	<input type="checkbox"/>
Transmit EIRP	<input type="text" value="15"/>	Advertise 802.11d and 802.11h Capabilities	<input type="checkbox"/>
Spectrum load balancing	<input type="checkbox"/>	Spectrum Load balancing mode	channel ▾
Spectrum load balancing update interval (sec)	<input type="text" value="30"/> seconds	Spectrum load balancing threshold (%)	<input type="text" value="20"/> percent
Advertized regulatory max EIRP	<input type="text" value="0"/>	Spectrum Load Balancing domain	<input type="text"/>
RX Sensitivity Tuning Based Channel Reuse	disable ▾	RX Sensitivity Threshold	<input type="text" value="0"/> -dBm
Non 802.11 Interference Immunity	Level-2 ▾	Enable CSA	<input type="checkbox"/>
CSA Count	<input type="text" value="4"/>	Management Frame Throttle interval	<input type="text" value="1"/> sec
Management Frame Throttle Limit	<input type="text" value="20"/>	ARM/WIDS Override	<input type="checkbox"/>
Protection for 802.11b Clients	<input checked="" type="checkbox"/>	Maximum Distance	<input type="text" value="0"/> meters

**Figure 30**     **Disable 802.11g radio**

The Wired AP profile must be configured to set up Ethernet ports on each AP as shown in [Figure 31](#)

- Go to **AP > Wired AP profile**.
- Create a Wired AP profile called “trusted”.
- Check the **Wired AP enable** box.
- For Forward mode, choose **bridge**.

When a mesh AP is in bridge mode, the AP handles all association requests and responses, encryption and decryption processes, and firewall enforcement.

Wired AP Profile

```
ap wired-ap-profile "trusted"  
    wired-ap-enable  
    forward-mode bridge  
ap wired-port-profile "default"  
    wired-ap-profile "trusted"
```

Profile Details

Wired AP profile >

--NEW--

trusted

Wired AP enable	<input checked="" type="checkbox"/>	Forward mode	<div>bridge</div>
Switchport mode	<div>access</div>	Access mode VLAN	<div>1</div> <-- <div>--NONE--</div>
Trunk mode native VLAN	<div>1</div> <-- <div>--NONE--</div>	Trunk mode allowed VLANs	<div>1-4094</div> <-- <div>--NONE--</div>
Trusted	<input type="checkbox"/>	Broadcast	<input checked="" type="checkbox"/>

Figure 31      Wired AP profile

Mesh radio profiles are available under Mesh, as shown in [Figure 32](#):

- Go to **Mesh > Mesh Radio profile**.
- Create a new Mesh Radio profile called "5G-Mesh".
- Set the Reselection mode to **reselect-never**.

The reselection mode is used to optimize the link metric algorithm. The reselection mode specifies a method that the mesh node can use to find a better uplink to the mesh portal. Changing reselection mode to "reselect-never" prevents the mesh node from constantly looking for better path to the mesh portal. This configuration is correct for point-to-point deployments because only one path exists between the mesh node and the mesh portal in a point-to-point network.

- Set Link Threshold to **1**.

Link threshold signifies the minimum RSSI required for a link to be considered optimum. In a point-to-point deployment, only one path exists between portal and point. Therefore, the Link Threshold must be set to the minimum, which is 1, as shown in [Figure 32](#).

### Mesh Radio Profile

```
ap mesh-radio-profile "5G-Mesh"
  link-threshold 1
  reselection-mode reselect-never
ap-group "Mesh"
  mesh-radio-profile "5G-Mesh"
```

Profile Details			
<b>Mesh Radio profile &gt;</b>			
--NEW-- 5G-Mesh			
Maximum Children	64	Maximum Hop Count	8
Heartbeat threshold	10	Link Threshold	1
Reselection mode	reselect-never	Metric algorithm	distributed-tree-rssi
Retry Limit	8	RTS Threshold	2333 bytes
802.11a Transmit Rates	<input checked="" type="checkbox"/> 6 <input checked="" type="checkbox"/> 9 <input checked="" type="checkbox"/> 12 <input checked="" type="checkbox"/> 18 <input checked="" type="checkbox"/> 24 <input checked="" type="checkbox"/> 36 <input checked="" type="checkbox"/> 48 <input checked="" type="checkbox"/> 54		
802.11g Transmit Rates	<input checked="" type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input checked="" type="checkbox"/> 5 <input checked="" type="checkbox"/> 6 <input checked="" type="checkbox"/> 9 <input checked="" type="checkbox"/> 11 <input checked="" type="checkbox"/> 12 <input checked="" type="checkbox"/> 18 <input checked="" type="checkbox"/> 24 <input checked="" type="checkbox"/> 36 <input checked="" type="checkbox"/> 48 <input checked="" type="checkbox"/> 54		
Mesh Private Vlan	0	Allowed VLANs on mesh link	1-4094 <-- --NONE--
BC/MC Rate Optimization	<input checked="" type="checkbox"/>		

**Figure 32 Mesh Radio profile**

To set up the Mesh SSID profile:

- Go to **Mesh Radio profile > Mesh High-throughput SSID Profile**, as shown in [Figure 33](#).
- Create a new Mesh High-throughput SSID Profile called **"HT-40MHz"**.
- Check the **40 MHz channel usage** box (default).
- For Supported MCS set, choose **"0-15"**. Aruba outdoor APs currently support MCS values up to 15 (default).
- Check the **Short guard interval in 40 MHz mode** box. With MCS rate at 15 and short guard interval enabled, is it possible to achieve data transfer speeds of up to 300 Mb/s (default).

### Mesh High-Throughput SSID Profile

```
ap mesh-ht-ssid-profile "HT-40MHz"
ap mesh-radio-profile "5G-Mesh"
mesh-ht-ssid-profile "HT-40MHz"
```

Profile Details			
<b>Mesh High-throughput SSID Profile &gt;</b>			
--NEW-- ▾		HT-40MHz	
High throughput enable (SSID)	<input checked="" type="checkbox"/>	40 MHz channel usage	<input checked="" type="checkbox"/>
MPDU Aggregation	<input checked="" type="checkbox"/>	Max transmitted A-MPDU size	65535 bytes
Max received A-MPDU size	65535 ▾	Min MPDU start spacing	8 ▾
Supported MCS set	0-15 <-- ▴	Short guard interval in 40 MHz mode	<input checked="" type="checkbox"/>
Legacy stations	<input checked="" type="checkbox"/>	Allow weak encryption	<input type="checkbox"/>

**Figure 33**      **Mesh High-throughput SSID profile**

A mesh cluster profile setting forms a logical set of mesh nodes that forms the common connection and mesh security parameters necessary to create mesh links. For complete information about the mesh cluster profile and its use cases, refer to the *ArubaOS User Guide*.

- Go to **Mesh > Mesh Cluster Profile** as shown in [Figure 34](#).
- Create a new profile called “**5G-Mesh**”.

### Create a Mesh Cluster Profile

```
ap mesh-cluster-profile "5G-Mesh"
ap-group "Mesh"
mesh-cluster-profile "5G-Mesh" priority 1
```

Mesh Cluster profiles		
Name	Priority	Actions
5G-Mesh	1	Delete

Add a profile default using priority 2 Add

**Figure 34** Create a Mesh Cluster profile

- Go to **Mesh > Mesh Cluster profile > 5G-Mesh**.
- Name the cluster “**aruba-mesh**”.
- For RF Band, choose “**a**” (default).
- Encryption select “**wpa2-psk-aes**”.
- Set the WPA2 Passphrase.

### Mesh Cluster SSID Profile

```
ap mesh-cluster-profile "5G-Mesh"
wpa-passphrase choose-a-good-one
opmode wpa2-psk-aes
```

Mesh Cluster profile > 5G-Mesh Show Reference Save As Reset

Cluster Name	aruba-mesh	RF Band	a
Encryption	<input type="checkbox"/> opensystem <input checked="" type="checkbox"/> wpa2-psk-aes		
WPA Hexkey	Retype:	WPA Passphrase	Retype:

**Figure 35** Mesh Cluster SSID profile



The IP address must be provisioned for the AP before the AP can join a controller. The IP address can be set manually or it can be assigned dynamically. To manually set an IP address, refer to AP provisioning as shown in [Figure 37 on page 53](#). For dynamic IP address provisioning, the network must have a DHCP server. It is highly recommended that an external DHCP server be used.

Connect the first AP to the controller via Ethernet.

- Go to **Configuration > AP Installation**

You should see the APs in the Unprovisioned row, as shown in [Figure 36](#).

The APs are currently not provisioned, which means that the controller can see the AP, but the AP cannot serve any clients. The next step is to provision the AP to an AP group as shown in [Figure 36](#).

- Select the AP that you want to use as the mesh portal.
- Click **Provision**.

Wireless > AP Installation > Provisioning

Provisioning

Provisioning Profile

RAP Whitelist

Campus AP Whitelist

Search

	AP Name ▲	AP Group ▲	AP IP ▲	AP Type ▲	AP MAC Address ▲
<input type="checkbox"/>	00:24:6c:cd:80:05	default	172.16.0.252	175P	00:24:6c:cd:80:05

1 | 1-1 of 110

Figure 36 AP Provisioning

Next you have the option to make changes to the AP:

- Select AP group **Mesh**. The AP must be provisioned under the AP group Mesh.
- Set the AP Installation mode to **Outdoor**. This will be an outdoor point-to-point network and therefore the AP needs to be set as an outdoor AP. ArubaOS automatically determines the channels and maximum allowed EIRP based on these settings.
- Set antenna gain to **14** dBi because the antennas used in this setup (Aruba AP-ANT-5614) have 14 dBi gain. Gain values for all Aruba-certified antennas are available on the data sheets.

**Wireless > AP Installation > Provision**

Provisioning | Provisioning Profile | RAP Whitelist | Campus AP Whitelist

**AP Parameters**

AP Group: Mesh

**AP Installation Mode**

☐ Default ☐ Indoor ☒ Outdoor

**External Antenna Parameters**

5 GHz Antenna Gain (dBi): 14 2.4 GHz Antenna Gain (dBi):

**Figure 37 AP Installation-1**

- For IP Settings, choose the **Obtain IP Address Using DHCP** option, as shown in [Figure 38](#).
- Name the AP.
- For the Mesh Role, choose **Mesh Portal**.
- Click **Apply and Reboot**.

**IP Settings**

☒ Obtain IP Address Using DHCP  
☐ Use the following IP Address

IP Address: Subnet Mask: Gateway IP Address: DNS IP Address: Domain Name:

**FQLN Mapper**

Remove FQLN: ☐  
 Campus: N/A Building: N/A Floor: N/A

AP IP Address	AP Name	AP Group	SNMP System Location	Mesh Role	AP Type	Serial Number
172.16.0.252	AP175_ba	default		Mesh Portal	175P	AY0000006

**Figure 38 AP Installation-2**

## AP Provisioning Summary

```

provision-ap copy-provisioning-params ip-addr <AP IP>
provision-ap installation outdoor
provision-ap no ipaddr
provision-ap a-ant-gain 14
provision-ap g-ant-gain 14
provision-ap external-antenna
provision-ap server-name aruba-master
provision-ap ap-group "Mesh"
provision-ap ap-name "AP175_ba"

```

```

provision-ap no syslocation
provision-ap mesh-role mesh-portal
provision-ap no remote-ap
provision-ap reprovision ip-addr <AP IP>

```

To provision the second AP as a mesh point, follow the steps for provisioning a mesh portal, but for the Mesh Role, choose **Mesh Point** instead.

## Validate Point-to-Point Links

- Go to **Monitor > Network Summary**.

Now both APs are listed in the Total Up column. The mesh portal and mesh point are up and ready for data transfer.

Network Summary				
WLAN Network Status				
	Total Up	Total Down	IPSEC Up	IPSEC Down
WLAN Controllers	<u>1</u>	<u>0</u>		
Access Points	<u>3</u>	<u>2</u>	<u>0</u>	<u>0</u>
Mesh Portals	<u>1</u>	<u>0</u>		
Mesh Points	<u>1</u>	<u>0</u>		
Air Monitors	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Wired Access Points	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Unprovisioned Access Points	0			
Duplicate AP Name	0			

**Figure 39 Network Summary**



The *ArubaOS User Guide* provides a comprehensive list of validation criteria to make sure the mesh portal and mesh point are working properly. That guide is available on the Aruba support site.

Now you are ready to disconnect the APs from the staging test bed and mount them outdoors.

# Appendix A: Aruba Controller DHCP Setup

- Go to **Network > IP > DHCP Server**, as shown in [Figure 40](#).
- Add a new DHCP server and provide the IP address range the DHCP server can support.

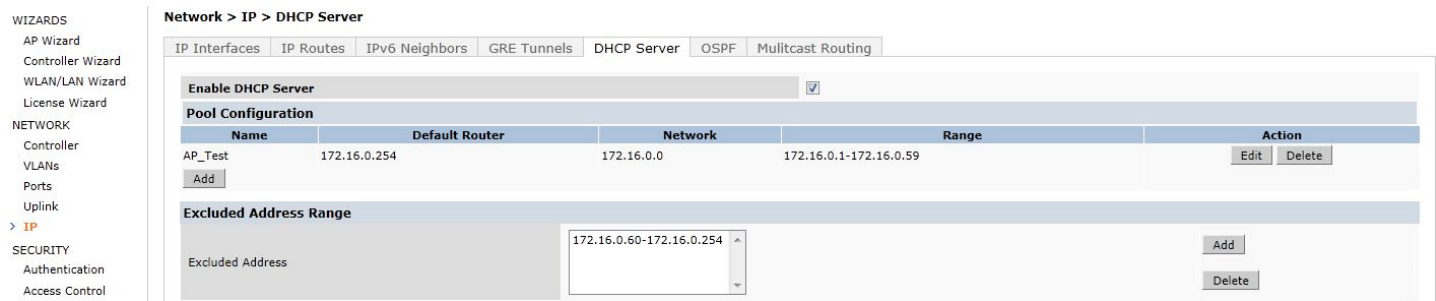


Figure 40 DHCP server setup

- Click **Apply Changes**.
- Click **Save Configuration**.



## Appendix B: Indoor AP + Outdoor Enclosure vs. Outdoor AP

Typically, AP cost is the only factor that pushes customers to use an indoor AP with an outdoor rated enclosure.



---

Aruba recommends using outdoor APs like AP-175, MSR2000, MSR4000, or MST200 in outdoor deployments simply because they are ready to deploy and have fewer variables to manage.

---

Aruba Outdoor APs are built using hardened enclosures and are much more durable than indoor APs with outdoor enclosures. Outdoor APs are built to operate at extreme conditions. These APs are precertified to withstand dust, rain, and certain minimum and maximum temperatures. Therefore when you use outdoor APs, you only ensure that the operating range is well within the minimum and maximum temperature ranges for the specific region. Refer to data sheet the specific AP for more information about environmental rating and operating temperatures.

To keep the total project cost low, customers sometimes choose to use an indoor AP for outdoor deployment. When indoor APs are placed outdoors, they should be placed only inside a NEMA-rated enclosure that is compliant for the specific region.



---

If you place an indoor AP outdoors without using the right enclosure, the AP and the network equipment behind the AP will be damaged.

---

The FCC also requires that APs that are mounted outdoors use only outdoor bands (UNII-2 and UNII-3) and all the indoor channels in UNII-1 band must be disabled. Indoor APs use indoor channels right out of the box, so you must make sure that the indoor channels are disabled. Refer to Chapter 4 for MeshOS channel allocation procedure and Chapter 5 for ArubaOS channel allocation procedures.



## Appendix C: Contacting Aruba Networks

### Contacting Aruba Networks

Web Site Support	
Main Site	<a href="http://www.arubanetworks.com">http://www.arubanetworks.com</a>
Support Site	<a href="https://support.arubanetworks.com">https://support.arubanetworks.com</a>
Software Licensing Site	<a href="https://licensing.arubanetworks.com/login.php">https://licensing.arubanetworks.com/login.php</a>
Wireless Security Incident Response Team (WSIRT)	<a href="http://www.arubanetworks.com/support/wsirt.php">http://www.arubanetworks.com/support/wsirt.php</a>
Support Emails	
Americas and APAC	<a href="mailto:support@arubanetworks.com">support@arubanetworks.com</a>
EMEA	<a href="mailto:emea_support@arubanetworks.com">emea_support@arubanetworks.com</a>
WSIRT Email Please email details of any security problem found in an Aruba product.	<a href="mailto:wsirt@arubanetworks.com">wsirt@arubanetworks.com</a>

Validated Reference Design Contact and User Forum	
Validated Reference Designs	<a href="http://www.arubanetworks.com/vrd">http://www.arubanetworks.com/vrd</a>
VRD Contact Email	<a href="mailto:referencedesign@arubanetworks.com">referencedesign@arubanetworks.com</a>
AirHeads Online User Forum	<a href="http://airheads.arubanetworks.com">http://airheads.arubanetworks.com</a>

Telephone Support	
Aruba Corporate	+1 (408) 227-4500
FAX	+1 (408) 227-4550
Support	
● United States	+1-800-WI-FI-LAN (800-943-4526)
● Universal Free Phone Service Numbers (UIFN):	
■ Australia	Reach: 1300 4 ARUBA (27822)
■ United States	1 800 9434526 1 650 3856589
■ Canada	1 800 9434526 1 650 3856589
■ United Kingdom	BT: 0 825 494 34526 MCL: 0 825 494 34526

## Telephone Support

### ● Universal Free Phone Service Numbers (UIFN):

■ Japan	IDC: 10 810 494 34526 * Select fixed phones IDC: 0061 010 812 494 34526 * Any fixed, mobile & payphone KDD: 10 813 494 34526 * Select fixed phones JT: 10 815 494 34526 * Select fixed phones JT: 0041 010 816 494 34526 * Any fixed, mobile & payphone
■ Korea	DACOM: 2 819 494 34526 KT: 1 820 494 34526 ONSE: 8 821 494 34526
■ Singapore	Singapore Telecom: 1 822 494 34526
■ Taiwan (U)	CHT-I: 0 824 494 34526
■ Belgium	Belgacom: 0 827 494 34526
■ Israel	Bezeq: 14 807 494 34526 Barack ITC: 13 808 494 34526
■ Ireland	EIRCOM: 0 806 494 34526
■ Hong Kong	HKTI: 1 805 494 34526
■ Germany	Deutsche Telekom: 0 804 494 34526
■ France	France Telecom: 0 803 494 34526
■ China (P)	China Telecom South: 0 801 494 34526 China Netcom Group: 0 802 494 34526
■ Saudi Arabia	800 8445708
■ UAE	800 04416077
■ Egypt	2510-0200 8885177267 * within Cairo 02-2510-0200 8885177267 * outside Cairo
■ India	91 044 66768150